

Gas Leak on Converter 1st Pass Outlet

$P/P_A = 1.231$ less than $1.893 \left[\frac{(k+1)}{2} \right]^{k/(k-1)}$ therefore the flow is non-choked (i.e. subsonic), and the following equation applies

$$Q = CAP \sqrt{(2g_c/ZRT)(K/K-1)[(P_A/P)^{2/K} - (P_A/P)^{(K+1)/K}]}$$

				psia	psig	in WC
Q = mass gas flow (lbs/s)		K = C_p/C_v of the gas		1.4		
C = discharge coefficient	0.65	P = source pressure absolute (lb/ft ²)	2606	18.1	3.4	94
Equivalent Diameter of hole (in)	0.25	P _A = ambient pressure absolute (lb/ft ²)	2117	14.7		
A = area of hole (ft ²)	0.00034	M = molecular weight of gas	34			
g _c = gravitational constant (ft/s)	32.17	Z = compressibility factor	1.077063			
R = gas constant (ft-lb/lb mol - °R)	1543.3	Release duration (seconds)	3,600			
T = temperature (°R)	1037	SO ₃ concentration in gas (wt%)	0			
	303 °C	SO ₂ concentration in gas (wt%)	1.0			
Molecular weight of SO ₃	80	Molecular weight of SO ₂	64			

Intermediate Calculations:

0.00127

3.5

0.74315

0.70031

0.57707

Mass Calculations:


Q = 0.0080 lbs/s

Total mass: 29 lbs

Total SO₃ mass: 0 lbs

Total SO₂ mass: 0.29 lbs

Reference: "Perry's Chemical Engineering Handbook, 6th Edition, McGraw-Hill 1984"

EXHIBIT #	4
REPORT	02bun
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DSF0001016

Gas Leak on CIP - Cold Side

$P/P_A = 1.172$ less than $1.893 \left[\frac{(k + 1)}{2} \right]^{k/(k-1)}$ therefore the flow is non-choked (i.e. subsonic), and the following equation applies

$$Q = CAP \sqrt{(2g_c/ZRT)(K/K-1)[(P_A/P)^{2/K} - (P_A/P)^{(K+1)/K}]}$$

				psia	psig	in WC
Q = mass gas flow (lbs/s)		K = C_p/C_v of the gas		1.4		
C = discharge coefficient	0.65	P = source pressure absolute (lb/ft ²)	2481	17.2	2.5	70
Equivalent Diameter of hole (in)	0.25	P _A = ambient pressure absolute (lb/ft ²)	2117	14.7		
A = area of hole (ft ²)	0.00034	M = molecular weight of gas	34			
g _c = gravitational constant (ft/s)	32.17	Z = compressibility factor	1.077063			
R = gas constant (ft-lb/lb mol - °R)	1543.3	Release duration (seconds)	3,600			
T = temperature (°R)	627	SO ₃ concentration in gas (wt%)	0			
	75 °C	SO ₂ concentration in gas (wt%)	1.0			
Molecular weight of SO ₃	80	Molecular weight of SO ₂	64			

Intermediate Calculations:

0.0021
3.5
0.79714
0.7618
0.54942

Mass Calculations:

Q = 0.0089 lbs/s
Total mass: 32 lbs
Total SO₃ mass: 0 lbs
Total SO₂ mass: 0.32 lbs

Reference: "Perry's Chemical Engineering Handbook, 6th Edition, McGraw-Hill 1984"

DSF0001017

Gas Leak on CIP - Hot Side

$P/P_A = 1.172$ less than $1.893 \left[\frac{(k+1)}{2} \right]^{k/(k-1)}$ therefore the flow is non-choked (i.e. subsonic), and the following equation applies

$$Q = C A P \sqrt{(2g_c/ZRT)(K/K-1)[(P_A/P)^{2/K} - (P_A/P)^{(K+1)/K}]}$$

				psia	psig	in WC
Q = mass gas flow (lbs/s)		K = C_p/C_v of the gas	1.4			
C = discharge coefficient	0.65	P = source pressure absolute (lb/ft ²)	2481	17.2	2.5	70
Equivalent Diameter of hole (in)	0.25	P _A = ambient pressure absolute (lb/ft ²)	2117	14.7		
A = area of hole (ft ²)	0.00034	M = molecular weight of gas	34			
g _c = gravitational constant (ft/s)	32.17	Z = compressibility factor	1.077063			
R = gas constant (ft-lb/lb mol - °R)	1543.3	Release duration (seconds)	3,600			
T = temperature (°R)	1113	SO ₃ concentration in gas (wt%)	25			
	345 °C	SO ₂ concentration in gas (wt%)	1.0			
Molecular weight of SO ₃	80	Molecular weight of SO ₂	64			

Intermediate Calculations:

0.00118
3.5
0.79714
0.7618
0.54942

Mass Calculations:

Q = 0.0066 lbs/s
Total mass: 24 lbs
Total SO₃ mass: 6 lbs
Total SO₂ mass: 0.24 lbs

Reference: "Perry's Chemical Engineering Handbook, 6th Edition, McGraw-Hill 1984"

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